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CONTENTS

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DOSAGE RATES AND APPLICATION METHODS WITH PCNB FOR CONTROL OF POTATO SCAB AND RHIZOCTONIA[1]

J. D. MENZIES[2]

Pentachloronitrobenzene (PCNB) has been shown to have great promise as a soil fungicide against certain plant pathogens. It is evidently quite selective in action, being particularly effective against *Rhizoctonia solani* Kuhn. (1,2,3,6,7). Its effectiveness against the potato scab organism *Streptomyces scabies* as previously reported is somewhat variable (3,4,5). The experiments reported here were conducted to obtain detailed information on dosage required for scab and rhizoctonia control; to measure toxicity to potatoes and duration of fungicidal effectiveness; and to test practical methods of application and mixing.

MATERIALS AND METHODS

PCNB was furnished as a 75 per cent wettable powder by the Olin Mathieson Chemical Corporation who market this material under the trade name Terraclor. All dosages referred to in this paper are in terms of active ingredient.

The field experiments were conducted in the lower Yakima Valley on Ritzville or Sagemoor fine sandy loam. These soils contain less than 2 per cent organic matter and have a cation exchange capacity of approximately 12 m.e. per 100 grams. The fields selected had been cropped numerous times to potatoes and contained a heavy uniform natural infestation of the pathogens being studied. The soil pH ranged betweeen 6.5 and 7.4, which is well within the tolerance for scab incidence.

The PCNB was mixed with fine sand in such proportions that it could be broadcast by hand on the surface of the plots in an accurate manner. It was found that if the sand were slightly damp when mixed with PCNB an even distribution without loss from dust drift could be obtained. Usually about 5 pounds of mix were used for a plot of 500 square feet. For experimental work this method is more dependable than using spreading machines.

In treatments where the material was incorporated by rotary tillage a Howard Rotovator was used. Discing was done with a heavy off-set disc.

Potatoes were planted with 2- or 4-row planting equipment and handled during the growing season in the usual commercial manner .All plots were 4 rows wide and sections of the two middle rows were taken at harvest time for yield, grade, and disease records. Samples were taken from the plots during the growing season to obtain some of the data.

[1]Accepted for publication March 29, 1957.
Contribution from the U. S. Department of Agriculture, Agricultural Research Service, and the Washington Agricultural Experiment Stations, cooperating. Published with the approval of the Director as Scientific Paper No. 1567, Washington Agricultural Experiment Stations.

[2]Microbiologist, Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, Irrigation Experiment Station, Prosser, Washington.

1954 Experiments

A preliminary field test was conducted in 1954 on Ritzville fine sandy loam to find the range of dosage of PCNB needed for scab control. For this purpose, rates of 0, 50, 100, and 150 pounds per acre were applied by rotary tillage to a depth of 6 inches on plots 10′ x 50′ in size with three replications. The effect of these treatments on yield and scab of White Rose potatoes is shown in table 1.

Scab control was very striking even with the 50 pound per acre treatment in which 73 per cent of the tubers were marketable compared to 14 per cent in the check. The plots of higher rates were essentially scab-free. The yield data reflect phytotoxicity which was expressed as delayed emergence and stunted growth, particularly at the higher PCNB rates.

These plots were replanted with potatoes in the spring of 1955 to measure the residual effects of PCNB both in scab control and plant injury. Yield and scab records for 1955 are given in table 2. Residual scab control, although significant, was much less than the year before. Confirmation of this was found in observing a replanting of an area in a commercial field where PCNB has been used successfully for scab control in 1954 at the rate of approximately 90 pounds per acre. The potatoes in 1955 were almost as scabby as in the untreated area. The plant injury effect in 1955 from the residual PCNB, as shown in yield reduction in table 2, is surprising in view of the decreased disease control. In 1954 the total yields were lower, even in check plots, but there was evident stunting in the residue plots all season, which was distinct enough to distinguish the different rates in each replicate. Since there is no published record of this occurring in other cases with PCNB, it may be related to the particular soils used in this study. The fact that the yield reduction from the 50-pound residual was very slight, may indicate that this effect is not a serious problem at rates likely to be used.

1955 Experiments

Using the results of 1954 as a guide, a more extensive experiment was conducted in a scab-contaminated commercial field in 1955 using rates of 0, 20, 40, 60, and 80 pounds per acre of PCNB.[3] All plots were 100′ long and 10′ wide on Ritzville fine sandy loam. Four methods of application were tried in an effort to find possibilities for reducing the dosage per acre and eliminating plant injury. These methods were as follows:

1. *Rotary tillage.* The PCNB was broadcast on the surface of the ground after discing and light harrowing. This material was then worked into the soil by two passes with a rotovator operating at 6″ depth.

2. *Discing.* PCNB was worked into the soil by 3 passes with an offset disc operated in the same direction each time. The depth of discing was approximately 6 inches. In commercial practices a better mix might be obtained by cross discing, a method that could not be followed on the long narrow plots.

[3]These experiments were conducted in cooperation with the firm of Balcom and Moe, on their potato crop.

TABLE 1.—*Effect of preplating treatment of soil with PCNB on yield of White Rose potatoes — 1954.*

Rate of PCNB	Total Yield	Yield in Grades on Scab Basis[1]		
		No. 1	No. 2	Culls
Lbs./Acre		Tons/Acre	Tons/Acre	Tons/Acre
0	15.0	2.0	11.2	1.8
50	12.0	9.0	3.0	0.0
100	11.6	11.4	.2	0.0
150	11.1	10.5	.6	0.0

[1]Grading System: No. 1: less than 5 per cent of surface area scabbed.
No. 2: between 5 and 25 per cent of surface area scabbed.
Culls: more than 25 per cent of surface area scabbed.

TABLE 2.—*Residual effect of previous-year soil application of PCNB on yield and scab in White Rose potatoes.*

Rate of PCNB Applied in 1954	Total Yield 1955	Yield in Grades on Scab Basis[1]		
		No. 1	No. 2	Culls
Lbs./Acre	Tons/Acre	Tons/Acre	Tons/Acre	Tons/Acre
0	10.4	.7	4.3	5.4
50	9.3	1.8	4.6	2.9
100	7.2	1.6	3.1	2.5
150	6.2	2.1	2.5	1.6

[1]Grading System: See table 1.

3. *Harrowing.* Broadcast application of PCNB on prepared ground was followed by a single harrowing to a depth of approximately 3 inches with a "finger weeder." In this treatment the final hill of potatoes was built from treated soil, but the seed piece and root zone were in untreated soil.

4. *Row Application.* In an attempt to simulate application and mixing in a band, the potatoes were planted first but not covered except by an inch of loose soil. PCNB was then applied in a strip 15" wide (½ row width) over the row. A finger weeder was used to fill the furrow level after which the row was hilled by hilling discs. The rates of PCNB used were ½ the amount used for the broadcast treatments.

All treatments and planting were done during a three-day period from April 13-15. Because of a possibility that the usual band placement of fertilizer might interfere with the performance of the fungicide the fertilizer was broadcast and disced in before planting. This proved to be somewhat unsatisfactory because the plants showed nitrogen deficiency before the end of the season, which resulted in lower-than-normal yields.

Records were made during the growing season on rate of emergence, total top growth and rhizoctonia stem damage. It will be seen in table 3 that PCNB when rototilled or disced had a definite delaying effect on early growth. There were no specific symptoms of injury other than slow sprouting. By harvest time this slow start had been overcome and final yield was not affected.

TABLE 3.—*Effect of PCNB soil treatments on emergence and early growth of White Rose potatoes as measured by dry weight of plants 45 days after planting.*

Rate of PCNB	Dry Wt. of Plants from a 10-plant Sample — Grams per Stem			
	Rototilled	Disced	Harrowed	Stripped
Lbs./Acre	Gms.	Gms.	Gms	Gms.
0	1.21	1.08	.90	.79
20	.78	1.10	.76	.92
40	.70	.93	1.08	.86
60	.85	.85	.80	.80
80	.49	.70	.95	.73

The data on rhizoctonia were recorded twice during the growing season for stem and stolon damage and at harvest for tuber sclerotia. These results are shown in table 4. The lowest rate of 20 pounds PCNB per acre, when either disced or rototilled, gave striking control of stem lesions. In the case of rotary tillage the incidence of infected stems was reduced from 84 per cent to 7 per cent by the 20-pound rate. The decreased effectiveness of discing (21 per cent infected stems at the 20-pound rate) was probably caused by less effective mixing.

TABLE 4.—*Effect of rate and method of application of PCNB on rhizoctonia control in White Rose potatoes.*

Rate of PCNB	Application Method	Rhizoctonia Infected Stems		Stolons per Stem Girdled	Tubers Marred by Sclerotia
		May 31	July 18		
Lbs./Acre		Per cent	Per cent	No.	Per cent
0	Rotary tillage	40.1	84.1	1.5	5.4
20	" "	6.1	6.6	.05	4.7
40	" "	2.7	0	0	1.4
60	" "	.9	2.7	0	0
80	" "	1.9	1.9	0	.2
0	Disced	25.2	81.9	2.3	4.2
20	"	4.0	21.0	.1	5.0
40	"	4.3	0	0	1.8
60	"	1.0	0	0	.4
80	"	0	6.0	.3	0
0	Harrowed	37.4	58.5	1.3	3.3
20	"	22.0	33.0	2.1	2.4
40	"	20.1	59.4	1.1	2.3
60	"	18.9	52.5	1.0	.9
80	"	19.0	27.5	.6	1.7
0	Stripped	49.6	43.0	1.3	2.7
10	"	30.2	56.0	.6	.9
20	"	14.4	30.7	.6	2.6
30	"	26.9	25.0	.2	1.4
40	"	19.1	39.0	.3	2.6

Tuber rhizoctonia expressed as the percentage of tubers thrown out of U. S. No. 1 grade because of sclerotia on the surface was also controlled by PCNB but in both the rotary tilling and discing treatments 40 pounds per acre were required.

The two harrowed treatments were not effective in rhizoctonia control indicating that the mixing methods used did not place the fungicide deep enough to protect the stems for their entire underground length.

The yield of tubers in this experiment is included in table 5. Some explanation is needed for the lack of yield increase that might be expected from the degree of control of rhizoctonia stem and stolon damage. Growing conditions seem to determine whether or not early season rhizoctonia is damaging. In the check plots with 80 per cent of the stems infected, severe damage could have occurred if the weather had remained cool. However, during late May and June growth was rapid. The rhizoctonia lesions remained superficial and very little complete girdling occurred. In the case of girdled stolons they were replaced by a later set that escaped infection. If this experiment had been conducted during a cool season, there would, undoubtedly, have been serious yield reductions from rhizoctonia damage.

TABLE 5.—*Effect of rate and method of application of PCNB on scab control in White Rose potatoes—1955.*

Rate of PCNB	Application Method	Scab Index	No. 1 Potatoes		Total Yield
			Scab Basis[1] Only	U. S. Grade	
Lbs./Acre			Per cent	Per cent	Tons/Acre
0	Rotary tillage	14.2	24.9	10.2	10.3
20	" "	10.1	45.5	11.3	9.2
40	" "	5.6	61.0	23.5	9.6
60	" "	.8	92.8	47.7	10.2
80	" "	.9	93.8	52.8	8.7
0	Discing	14.2	28.2	4.7	10.2
20	"	2.7	86.8	41.5	11.0
40	"	3.6	82.2	30.1	9.3
60	"	.9	95.6	54.8	9.3
80	"	1.7	87.9	49.0	9.6
0	Harrowing	6.6	53.7	8.8	10.4
20	"	4.3	70.4	24.1	10.3
40	"	4.3	75.3	27.2	9.8
60	"	3.6	80.8	32.9	9.8
80	"	8.1	61.1	15.6	10.0
0	Stripped[2]	17.7	17.0	.9	10.8
10	"	6.5	59.8	16.4	10.3
20	"	2.8	82.3	27.1	10.3
30	"	5.7	62.5	22.0	9.8
40	"	5.5	64.4	24.0	10.7

[1]Includes all tubers with less than 5 per cent of the surface scabbed regardless of other defects.
[2]Note dosage per acre in all strip applications is ½ that of the other treatments.

The effect of the rates and application methods on control of scab are reported in a number of ways in table 5. For purposes of close comparisons the scab indices are the most precise because the tubers from each plot were carefully graded into seven scab classes from which the average index is calculated. Maximum benefits were reached at the 60-pound rate for both rotary tillage and discing. Results at lower rates are somewhat variable. If the 20-pound-disced treatment is considered out of line, then it would appear that satisfactory scab control can be obtained in this type of soil at 40 to 60 pounds PCNB per acre.

Results with the harrowed and stripped treatments were variable but there are suggestions of effective scab control in the strip application. Undoubtedly it is simply a matter of getting the material mixed in the soil at the right location.

Further data on rhizoctonia control with PCNB were obtained by a supplemental experiment on late potatoes at another location. In this case PCNB was applied prior to planting by broadcasting and discing at rates of 0, 5, 10, 20 and 40 pounds per acre. Plots were 10′ wide by 100′ long. Russet Burbank potatoes were used in this test. The results are summarized in table 6. Even 5 pounds per acre of PCNB greatly reduced the stem canker stage of rhizoctonia. As in the previously described experiment, the incidence of tuber sclerotia was not reduced by rates below 40 pounds.

TABLE 6.—*Effect of rate of PCNB on rhizoctonia control in Russet Burbank potatoes, 1955.*

Rate of PCNB	Stems Infected by Rhizoctonia	Tubers Marred by Sclerotia
Lb./Acre	Per cent	Per cent
0	66.1	14.3
5	18.5	13.2
10	19.3	11.8
20	1.8	9.7
40	1.0	5.5

DISCUSSION

PCNB is shown in these experiments to be a highly effective soil fungicide for rhizoctonia control in potatoes under certain conditions. It can be disced into the soil before planting at rates of 10-20 pounds active ingredient per acre and, if thoroughly incorporated in the soil, should give almost complete control in this type of soil. The same conclusions are justified for scab control except that three times as much fungicide per acre is required.

Only rotary tillage and discing were satisfactory methods of mixing PCNB in the soil for control of these potato diseases. The failure of harrowing as a mixing method is believed to be due to the immobility of PCNB in soil. With this treatment the harvested potatoes showed great variation in the amount of scab. When a few hills were harvested by hand it was noted that the upper tubers in the hills were scab-free, whereas the

lower tubers were scabby. A similar situation occurred in the strip-application treatment. It is concluded that PCNB must be mixed into the soil at least as deep as the seed piece to protect most of the tubers. Consequently the fungicide will have to be applied at or before planting.

A rate of 50 pounds per acre is roughly equivalent to a concentration of 25 parts per million in the top 6 inches of soil. Since PCNB does not move appreciably in the soil and since protection from the two pathogens involved is needed only in the stem, stolon and tuber zone, it is evident that confining applications to this zone would require considerably less material per acre than broadcast treatment.

Until machinery is devised that will do this type of mixing, the use of discing is recommended. Any slight advantage from rotary tillage would not outweigh the cost and time required for this operation.

These experiments were conducted with irrigation on fine sandy loam low in organic matter. In each case the land had produced potatoes the previous year so that there was very little undecomposed plant residue in the soil at time of treatment. These features are emphasized because they indicate a limitation to the use of this fungicide. For example, a commercial trial of PCNB was made by a grower in 1956 using PCNB at both 20 and 40 pounds per acre. Several fields were treated but in each case either a green manure crop of winter cereal was plowed in before treatment or it was made on plowed grain stubble. Under these conditions no significant reduction in rhizoctonia damage or scab incidence could be seen, nor was there any improvement in yield of marketable potatoes. It is believed that the plant residue and cloddy structure interferred with mixing the fungicide by discing to the point that control was not achieved at the relatively low rates used.

The results here reported not only demonstrated the ability of PCNB to control scab and rhizoctonia in potatoes but also point out the practical problems relative to distributing the material throughout the soil mass. This problem is one that will be common to all attempts to use insoluble, non-volatile fungicides in soil. Its solution will depend upon the improvement of mixing machinery and methods of application. Even so, the practicality of using such materials will be limited by clods, plant residue and basically by the limits to which we should go in destroying soil structure in order to add the fungicide.

Summary

Pentachloronitrobenzene (PCNB) controlled potato scab in fine sandy loam of the Yakima Valley when applied at the rate of 50 pounds per acre broadcast before planting and mixed by discing or rotary tillage. Mixing with a harrow in the top 2 inches of soil was ineffective even when 80 pounds per acre were used. Control was also unsatisfactory when the material was applied after shallow planting followed by harrowing and hilling.

The stem-canker stage of rhizoctonia was controlled similarly with PCNB at the rate of 10 to 20 pounds per acre. Tuber sclerotia, however, were not controlled until rates of 40 to 50 pounds per acre were used. At these rates there was no reduction in total yield of tubers but some

delay in emergence resulted. Limited data indicate only slight residual disease control in the second year.

These results were obtained with irrigation on fine sandy loam low in organic matter but at very high levels of infestation of the pathogens. Observations indicate that undecomposed plant residue in the soil may interfere with mixing and thus seriously reduce the effectiveness of treatment.

Literature Cited

1. Brinkerhoff, L. A., E. S. Oswald and J. F. Tomlinson. 1954. Field tests with chemicals for the control of Rhizoctonia and other pathogens of cotton seedlings. Pl. Dis. Reptr. 38: 467-482.
2. Campbell, Leo. 1954. An economical control of black root of cauliflower. Pl. Dis. Reptr. 38: 859.
3. Hooker, W. J. 1954. Pentachloronitrobenzene soil treatment for potato scab and rhizoctonia control. Pl. Dis. Reptr. 38: 187-192.
4. Hougland, G. V. C. and Lillian Cash. 1954. Effectiveness of certain soil fungicides in control of potato scab. Pl. Dis. Reptr. 38: 777-780.
5. ———— and ————. 1957. Carry-over effects of PCNB applied to the soil for control of potato scab. Amer. Potato Jour. 34: 85-88.
5. Kendrick, J. B., Jr. and John T. Middleton. 1954. The efficacy of certain chemicals as fungicides for a variety of fruit, root and vascular pathogens. Pl. Dis. Reptr. 38: 350-353.
7. Moore, W. D. and R. A. Conover. 1955. Chemical soil treatments for the control of Rhizoctonia on snap beans. Pl. Dis. Reptr. 39: 103-105.

A KNOBBY TUBER DISEASE OF THE POTATO[1]

REINER BONDE AND DONALD MERRIAM[2]

What appears to be an undescribed potato disease has occasionally been observed in the experimental fields at Aroostook Farm, Presque Isle, Maine. The name "knobby-tuber disease" is proposed. It was first observed in the Katahdin variety in 1951. Since then it, or a very similar disease, has been noted in an unnamed seedling and in plants of the Chippewa, Green Mountain, Cherokee, and Saco varieties.

The disease sometimes is tuber perpetuated (Figure 1, right) but some of the plants grown from diseased tubers appear to recover from the disease.

The diseased plants are more or less dwarfed. The stems of infected Katahdin plants have shortened internodes and a tendency to form adventitious branches in the leaf axils. Infected Green Mountain plants may have rather spindling stems similar to those produced by the witches'-

FIGURE 1.—*Left*: Knobby-tuber disease in Saco variety produced by inoculation with spindle-tuber plants. *Right*: Knobby-tuber disease occurring naturally in Katahdin variety. Note the dark mother tuber at upper left which produced this plant.

[1]Accepted for publication April 8, 1957.

[2]Plant Pathologist and Field Assistant, respectively, Maine Agricultural Experiment Station, Orono, Me.

broom virus. The plants maintain their green color throughout the growing season and do not die prematurely.

Most of the tubers of diseased plants are very knobby and misshapened (Figure 2). Some of the tubers of diseased hills, however, may be normal in appearance or slightly deformed. Other tubers are slightly elongated and somewhat similar to those with the spindle-tuber disease. Infected tubers of the Chippewa and Green Mountain varieties may have an internal vascular discoloration. This symptom is less severe when present in the Katahdin variety.

FIGURE 2.—*Left*: Katahdin plant with knobby-tuber disease. *Right*: Katahdin plant with normal tubers. Both plants were grown under the same field conditions.

The cause of the disease is not known. Bacteria were isolated from the discolored vascular ring of the knobby tubers. Attempts to produce the disease by inoculation of healthy potato seed pieces with these bacteria, however, have failed to produce knobby tubers.

There is evidence that the knobby-tuber disease may be caused by a virus similar to that which produces potato spindle tuber. The disease was not transmitted from diseased to healthy Katahdin plants by the peach aphid *Myzus persicae* Sulz. or by artificial sap inoculation. It also was not transmitted in a limited number of tuber grafts. However, the knobby-tuber symptoms were readily produced in the Saco variety by brushing and

switching young and actively growing plants with Katahdin plants infected with spindle tuber. Figure 1 depicts knobby tubers in the Saco variety produced by the spindle tuber inoculations in comparison with the knobby tuber disease in the Katahdin variety. Saco plants inoculated in the same manner using plants with knobby tubers did not develop the disease. (Table 1).

TABLE 1.—*Comparison of disease trasmission from Katahdin plants to plants of the Katahdin and Saco varieties*[1]

Disease	Plants Infected	
	Katahdin	Saco
	Per cent	Per cent
Yellow spot	0	0
Apical leafroll	0	0
Knobby tuber	0	0
Severe Virus X	100	0
Spindle tuber	100	60 Spindle-tuber 40 Knobby-tuber

[1] Inoculations made by severely brushing and switching the young and actively growing plants with diseased Katahdin plants.

It is of interest that two types of symptoms were produced in the Saco variety when inoculated with spindle tuber by the "brushing and switching" method. Some of the plants developed tubers with typical spindle tuber symptoms. Other plants developed extremely knobby tubers.

It is interesting that severe virus X and spindle tuber were easily transmitted by the brushing and switching method of inoculation and yellow spot and apical leafroll were not transmitted in this manner.

POTATO PITTING DURING WASHING[1]

RICHARD S. CLAYCOMB AND JOHN C. HANSEN[2]

INTRODUCTION

Washing potatoes prior to packaging for market is becoming an increasingly popular practice. Pits which appear as small dents have been observed on mature potatoes after they have been washed. Usually inconspicuous immediately after potatoes are washed, the pits, which frequently do not break the skin, can be easily seen 24 to 48 hours later. A shipment of potatoes that left a warehouse in apparently good condition during the winter of 1955-1956 was so badly pitted at destination that it was the subject of customer complaint and inquiry. Figure 1 shows a potato without pits (No. 1) compared with potatoes pitted with increasing severity (No. 2, 3, and 4) 48 hours after washing.

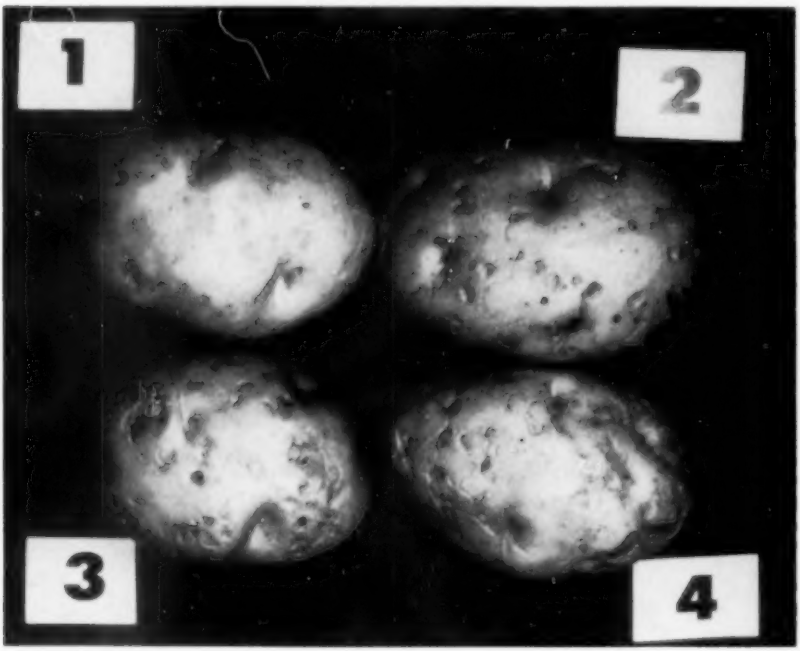


FIGURE 1.—Examples of unpitted and pitted washed potatoes. 1, unpitted; 2, 3, and 4, pitted with increasing severity.

[1]Accepted for publication April 30, 1957.
[2]Agricultural Engineer, Transportation & Facilities Branch, and Associate Horticulturist, Biological Sciences Branch, respectively, Agricultural Marketing Service. U. S. Department of Agriculture, East Grand Forks, Minn.

The belief that pitting of this type occurs quite generally was confirmed when it was observed during the winter of 1955-1956 at six warehouses in the Red River Valley of North Dakota and Minnesota where potatoes were being washed.

Procedure

Quantitative tests of an exploratory nature were conducted at the Red River Valley Potato Research Center in 1955 and 1956 to determine whether or not the rubber-scrubber material commonly found in potato washers caused this particular type of pitting and if so, to determine what could be done by wash plant operators to minimize the condition.

Most potato washing equipment incorporates a series of rollers over which potatoes pass while they are sprayed from above with clean water (Figure 2).

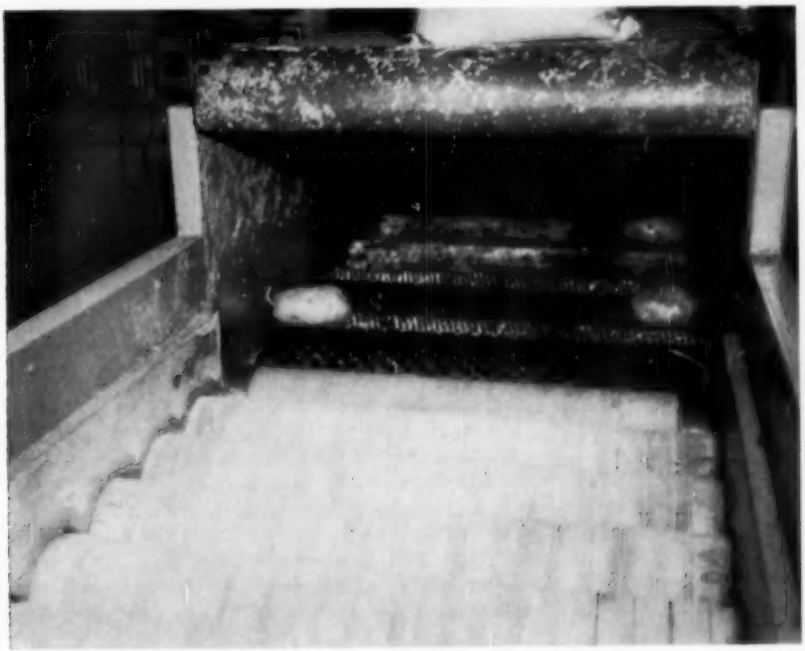


Figure 2.—Discharge end of a potato washer.

Strips of rubber-scrubber material are often fastened to the rollers to loosen the more firmly adhering soil. Many little rubber fingers called pintles bristle from such rollers (Figure 3). These pintles scrub the potatoes more or less vigorously depending upon how fast the rollers are turning.

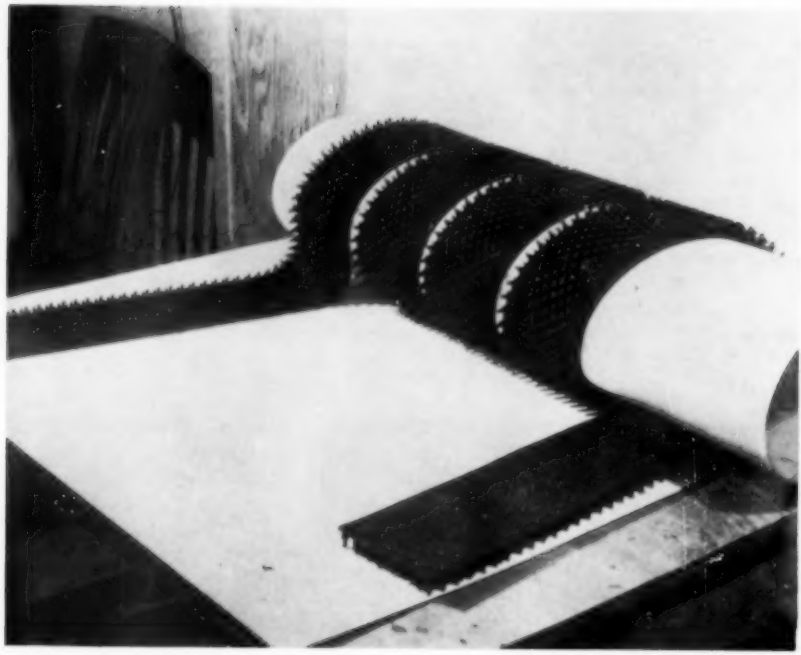


FIGURE 3.—A type of rubber-scrubber material used to cover potato washer rollers (by courtesy of Gates Rubber Company).

Rubber-scrubber material is identified by the manufacturer according to degree of hardness as determined by durometer tests. Present scrubber material is available in hardness ranging from 40-durometer to 70-durometer with the harder 60- to 70-durometer rubber being most widely used in potato washers when these tests were conducted.

New and worn 60-durometer scrubber material and new 40-durometer material was tested at several roller speeds and potatoes were scrubbed for varying lengths of time. Used, 40-durometer material was not tested. Treatments were replicated four times, each replication consisting of 45 to 50 pounds of mature Red Pontiac potatoes that had been stored 3 to 5 months.

The interval between treatment and examination for pitting was approximately 48 hours. Potatoes were scored as being pitted when a tuber had one or more pits. The percentage of pitted potatoes was calculated on the basis of original weight.

The exploratory nature of the tests and time element involved made it impractical to conduct all of the tests in one season with potatoes strictly comparable in injury susceptibility. The 24-inch wide washer used in all the tests had five 5-inch diameter transverse rollers covered with rubber-

scrubber material interposed between vegetable-fiber and nylon-bristle rollers.

Results

The results obtained in the various tests are summarized in table 1. New 60-durometer material tested in February 1955 pitted 35 per cent of the potatoes scrubbed 0.5 minutes and 90 per cent of those scrubbed 2.0 minutes at a 95 r.p.m. roller speed. Thirty-five per cent pitting was noticeably detrimental to the general appearance of the potatoes. Ninety per cent pitting detracted seriously from their appearance.

The same 60-durometer material was tested in December 1955 when the pintles were worn and blunted from washing approximately 30,000 bushels of potatoes. Washing time for the test lots fed through the washer during normal commercial operations was held as nearly constant as could reasonably be expected but varied from 0.19 to 0.50 minutes for individual potatoes of various shapes and sizes. Forty-one to 97 per cent of the potatoes were pitted at roller speeds of 48 to 92 r.p.m. and appearance was seriously affected by the pits.

Table 1.—*Degree of potato pitting as affected by conditions and relative hardness of rubber-scrubber material, roller speed, and scrubbing time.*

Date of Test	Condition of Rubber	Rubber Hardness	Roller Speed	Scrubbing Time	Potatoes Pitted
		Durometer	R.P.M.	Minutes	Per cent
Feb. 1955	New	60	95	0.50	35
Do	do.	60	95	1.00	66
Do	do.	60	95	2.00	90
Dec. 1955	Worn	60	48	0.19 to 0.50	41
Do	do.	60	60	0.19 to 0.50	80
Do	do.	60	92	0.19 to 0.50	97
Jan. 1956	New	40	52	0.19 to 0.50	0
Do	do.	40	102	0.19 to 0.50	0
Do	do.	40	102	2.00	0
Do	do.	40	102	4.00	0

A month later the worn 60-durometer material was replaced by new 40-durometer material. Potatoes scrubbed by this material during normal commercial operations were unpitted at 52 and 102 r.p.m. roller speeds. Test lots of potatoes deliberately held in the washer for 4 minutes were not pitted at 102 r.p.m. roller speed, but the red skin was polished through on the high spots to the white tissue underneath.

Summary

The tests demonstrated that 60-durometer rubber-scrubber material, both new and worn, pitted mature potatoes severely enough to detract from

their appearance. The degree of pitting increased with roller speed and length of time potatoes were exposed to the scrubber rolls.

New 40-durometer rubber-scrubber material did not pit potatoes when they were subjected to a high roller speed for a longer time than would be expected during normal washing operation .

Recommendations

The relative cleaning ability of 60-durometer and 40-durometer rubber-scrubber material was not determined in these tests. But even in the absence of knowledge of relative cleaning efficiency the following is recommended:

1. Keep washer roller speed to the slowest r.p.m. that will effectively clean the potatoes. This will reduce pitting and probably reduce pintle wear.
2. Stop the washer when the flow of potatoes to it stops. Most washers are but partially self-emptying and will continue to scrub the trapped potatoes until they are displaced by additional potatoes or until the washer is deliberately cleared.
3. Replace 60-durometer scrubber material with 40-durometer rubber, and use 40-durometer rubber on all new equipment.

NEWS AND REVIEWS

HOTEL AND MOTEL ACCOMMODATIONS CONVENIENT TO ANNUAL MEETING, PLANT INDUSTRY STATION, BELTSVILLE, MARYLAND

EXPLANATION OF SYMBOLS ON ACCOMPANYING MAP

Transportation:

1. Greyhound Bus Line, 1110 New York Avenue, N. W.
   Bus direct to Plant Industry leaves 7:05 a.m., enters grounds and stops in front of Administration Building. Returns 4:35 p.m., from Station to Washington, D. C.

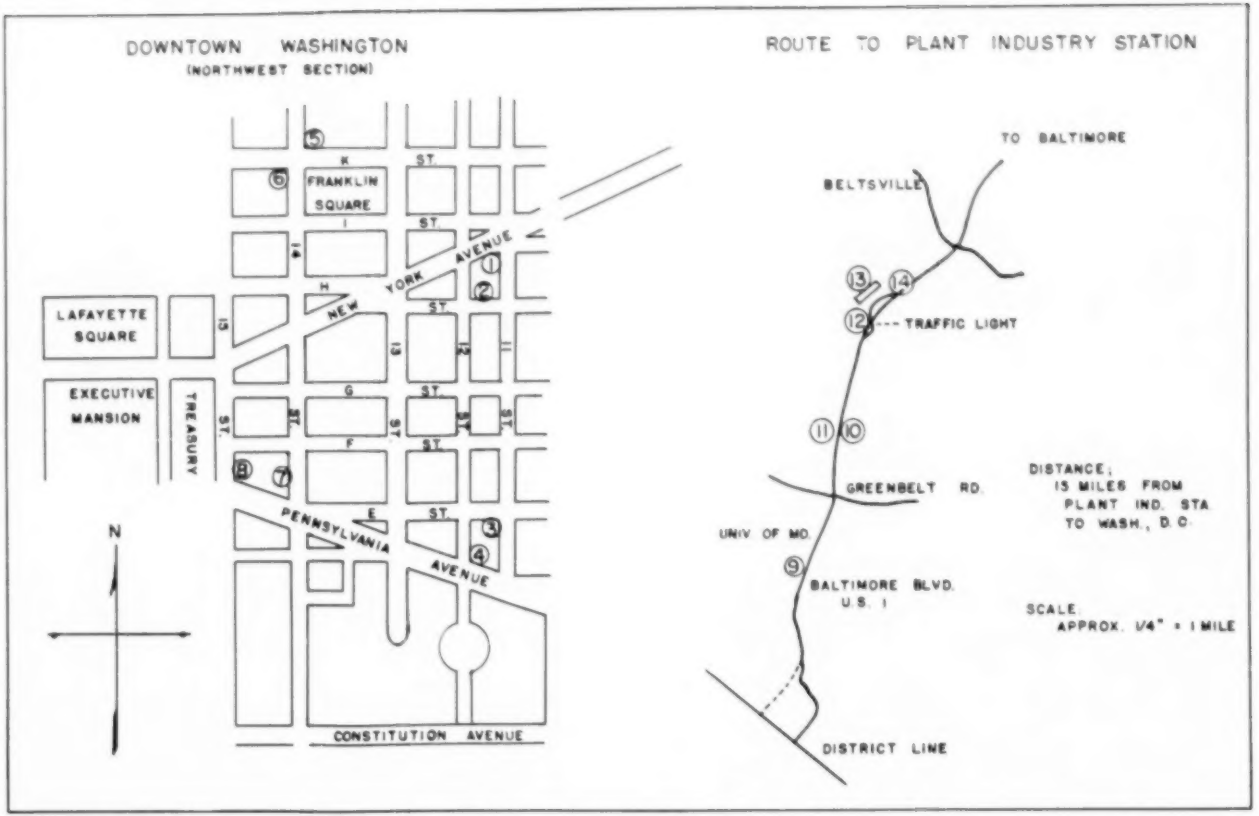
   Baltimore local busses along highway run approximately every half hour (starting on the hour) during the day.

   Ticket: Eighty-five cents (.85) round trip Washington/Berwyn, Maryland. Ten trip commuters' ticket Washington/Berwyn—$2.40.

Hotels in downtown Washington, D. C., conveniently located to the Greyhound Bus Terminal:

Name of Hotel	*Rates* *Single with Bath*	*Double with Bath*
2. Annapolis Hotel[1] 1111 H St., N.W.	$6.00—$ 9.00	$ 9.00—$11.00 $ 9.50—$12.00 (twin beds)
3. Hotel Harrington 11th & E St., N. W.	$5.50—$ 7.00	$ 8.50—$12.00 $ 9.50—$12.00 (twin beds)
4. Raleigh Hotel 12th & Pennsylvania Ave., N. W.	$6.00—$10.00	$ 9.00—$16.00 $11.00—$16.00 (twin beds)
5. Hamilton Hotel 14th & K Sts., N.W.	$6.00—$ 9.50	$ 8.50—$12.50 $10.00—$12.50 (twin beds)
6. Ambassador Hotel 1412 K St., N.W.	$6.00—$10.00	$ 9.00—$12.00 $10.00—$15.00 (twin beds)
7. Willard Hotel 14th & Pennsylvania Ave., N. W.	$8.00—$12.00	$12.00—$15.00 $13.00—$18.00 (twin beds)
8. Washington Hotel 15th & Washington Ave., N. W.	$7.50—$ 8.50 and $10.00	$12.00—$13.50 and $16.00

[1]This is the most convenient hotel to bus station; situated right in back of bus terminal; ask for rooms on front of building (away from noise of busses).



Map of downtown Washington and route to Plant Industry Station (13), Beltsville, showing location of Hotels and Motels. Symbols are explained on adjacent pages. Take New York Avenue to Route 1 and Beltsville if driving.

Motels in the vicinity of Plant Industry Station, Beltsville, Maryland.
(Prices might be slightly lower in December)

	Rates
9. Lord Calvert Hotel and Cottages 7200 Baltimore Ave., College Park, Md.	$3.00 & $4.00, per person depending on location; winter rates are somewhat cheaper. The foregoing rate is for twin-bedded rooms with bath.
	Single with Bath — *Double with Bath*
10. Royal Pine Motel 913 Baltimore Ave. College Park, Md.	$5.00—$6.00 — $3.50—$4.50 each
11. Hillcrest Motor Court 9122 Baltimore Blvd. College Park, Md.	*Motels*—$4.00 per person, 2 to a room, 2 beds, shower, steam heat and TV. *Hotel*—$3.00 per person, 2 to a room, 2 beds, shower, steam heat and TV. Also have family units.
12. Del Ha n White House Motel 10260 Baltimore Ave. College Park, Md.	$5.00—$6.00 $8.00 for 2 (twin beds) Suites of rooms with bath—3 to 4 people to a suite—$3.00 to $4.00 per person. Double beds a little cheaper. Breakfast can be arranged for in advance to be served at any requested time; also can arrange for other meals.
14. Farm Motel 10450 Baltimore Blvd. Beltsville, Md.	Two (2) persons—$6.00 Family units to sleep 6 including 3 double beds with double bath for $14.00. Other units — 2 baths, 2 rooms, 2 double beds and 2 roll-a-way beds, in all to sleep 6, costs $16.00.
13. Meeting Headquarters, Administration Building, Plant Industry Station	

Mention you are attending the Potato Association Meeting. Motels may possibly arrange for better rates .

CALL FOR PAPERS

The next Annual Meeting of the Potato Association of America will be held at the United States Department of Agriculture Plant Industry Station, Beltsville, Maryland, December 2, 3 and 4, 1957.

Please send titles of papers to be presented at the annual meeting to W. J. Hooker, Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan, by October 15. Include approximate time required to present papers, and if illustrated the size of slides to be used, also names and official addresses of authors as you

wish them to appear in the program. It is customary to have mimeographed abstracts of these papers for distribution to the members at the annual meeting. For that reason, the abstracts should accompany the title of the paper. Otherwise, mimeographed abstracts of your paper may not be available for distribution. Abstracts should be limited to approximately 100 words.

Good papers dealing with potato quality, storage, transportation problems and marketing are especially encouraged.

Your cooperation in sending in titles early, thus making it possible for the mimeographing of abstracts and preparation and printing of programs, will be greatly appreciated. Titles received after the deadline may not be accepted. Please bring this notice to the attention of your students and colleagues.

The back log of papers for publication in the American Potato Journal is low. Relatively prompt publication of papers will be possible if manuscipts are submitted immediately following presentation of the paper.

W. J. HOOKER, *Secretary*

THE POTATO INDUSTRY IN ALASKA[1]

C. H. DEARBORN[2]

The potato industry in Alaska is very young but very important in the agricultural economy of the Territory. Small acreages of potatoes, varying from 1 to 3 acres are grown on many farms. Homesteaders especially, have found that potatoes are one of the few crops that they can grow and still have fishing or construction work as their major source of income during the potato growing season. As in other potato growing regions, the trend here is toward larger operating units under a single management. Mechanization to avoid high labor costs probably accounts for this trend. Potatoes represent by far the largest cash crop grown in Alaska. About 1200 to 1400 acres are produced annually with a yield varying from 8 to 9 tons of U. S. No. 1 tubers (250 to 300 bushels) per acre.

If the composition of the crop now being grown were suitable for chipping and processing by restaurant trade, the tonnage from an additional 800 acres could be marketed. It is not to be inferred that the right variety of potato would be the simple solution, for many unsolved problems of the far north lie within this area of additional production and marketing. A great deal of salesmanship will be required together with storage know-how before the product of such additional production will occupy the grocery shelf space now occupied by Stateside potatoes.

HISTORY

A better understanding of the industry's position may be gained from a look at the early history of the areas in production. During the past 40 years potatoes have been grown from Sitka in the panhandle area to

[1]Accepted for publication July 5, 1957.

[2]Horticulturist, Agricultural Experiment Station, Palmer, Alaska.

Kotzebue on Norton Sound and in the major river valleys of Alaska such as the Copper, Matanuska, Susitna, Kuskokwim, Yukon and Tanana. Production centered around gold mining camps and roadhouses because the limited road system made it impractical to transport this heavy product very far from the site of production. Commercial fertilizers were not available and yields were low as compared with present standards. A considerable amount of kelp and fish waste were used wherever they were available. In those early days land clearing was expensive and laborious. Methods of clearing have changed markedly, now that the bulldozer with scarifier blade has become available in the more populated agricultural areas. This newer method of land clearing costs the landowner about $250 per acre for the kind of job necessary for immediate planting to potatoes (Figures 1 and 2).

FIGURE 1.—Land turned for the first time with a "Breaker" plower may appear from the distance to be about ready for planting. Many hours of hand labor for picking roots are still needed before a satisfactory seed bed can be prepared.

FIGURE 2.— The remains of an old stump row in this field of Green Mountain potatoes illustrates how the cost of land clearing lingers on long after the initial bill is paid. The bald knoll on the left reflects the shallowness of the soil mantle in some areas.

Environment and Culture

Today Alaska's potato production is distributed approximately as follows: Matanuska Valley, 60 per cent; Tanana Valley, 35; Kenai Peninsula, 2 and all other areas combined 3 per cent. Favorable weather conditions account for a part of this distribution of acreage but proximity to markets is, by far, the most important single factor. Practically the entire acreage is grown on mineral soils, less than 1000 feet above sea level.

Recent research findings in Alaska have brought about a modernization of the industry. Hand planting and horse drawn equipment have been replaced by tractor-drawn machinery. Fertilization has increased from 30 pounds of nitrogen, 60 pounds of phosphorus as P_2O_5 and 30 pounds of potassium as K_2O per acre, to 60-180-120 pounds, respectively, of the above elements. Growers formerly dropping seed pieces at 15 to 18-inch intervals in rows 40 to 48 inches apart are now planting the seed pieces at 7 to 11-inch intervals in rows 36 to 38 inches apart. Chemical control of chickweed, lambsquarters and mustard is effected with one pre-emergence spraying of a dinitro compound such as "Premerge". In a few instances where quackgrass has been allowed to propagate for forage purposes a single spraying with Dalapon on the lush vegetation, early in the spring before plowing, has made it possible to produce a satisfactory crop of potatoes within the season of treatment.

A few of the more progressive growers in the Matanuska Valley are using overhead irrigation during June and early July. Figure 3 shows

Figure 3.—A field of variety 114-3 potatoes being prepared for irrigation.

irrigation pipe in a potato field. After this time the season becomes progressively more moist although relatively little rainfall actually occurs during the growing season. If it were not for the cool daytime temperatures of 55 to 70°F in the Matanuska Valley and 60 to 85°F in the Tanana Valley with correspondingly low night temperatures of 40 to 50°F, the 11 to 14 inches of annual precipitation would be very inadequate for potato production. Irrigation fits into the production schedule easily because no spraying or dusting is necessary for insect or disease control.

Late blight has never been observed in Alaska by the writer. It was

reported from southeastern Alaska nearly 10 years ago. Whenever tubers are imported great care is taken to avoid introducing late blight-infected stock. Although visible symptoms of virus diseases, as well as ring rot and black leg, are prevalent in non-certified stocks of potatoes, a carefully conducted certified seed production program under the Crop Improvement Association guidance has resulted in a plentiful supply of disease-free seed.

Potato planting begins about May 10th and continues for four to five weeks, depending upon the area. Frequently, the frost line at this time is still only eight inches below the surface of the soil. Potato sprouts are slow in starting in this cold soil unless the seed pieces are green-sprouted. Once the potato sprout emerges above ground the rate of top growth is almost beyond comprehension. In the perma-frost areas of the Tanana Valley a good growth is made where the frost line remains within eighteen inches of the soil surface. The gradual thawing below the plow sole as the season progresses provides the crop with a slowly available source of water. The rapid growth is primarily caused by the long period of daylight prevailing in Alaska. During the period from May 20 to June 20 the sun rises between 3:00 and 4:00 a. m. and sets between 8:40 and 9:30 p.m. providing approximately 18 hours of daylight. It is light enough all night to travel without a light. By the end of September, however, there are only 11 hours of sunlight per day.

Frosting of the potato tops has been known to occur in June and July and particularly in mid-August. Yields are materially reduced by frosts in August because vines recover slowly at this late stage of development.

Varieties

Nearly every one of the named Stateside varieties of potatoes has been grown in Alaska at some time. Those that have persisted are Green Mountain, Arctic Seedling, White Bliss, Extra Early Eureka, Triumph, Early Ohio and Victor. The varieties carried today under the names Arctic Seedling and White Bliss are for all practical purposes the same as Green Mountain. Undoubtedly, White Bliss as a distinct variety was lost approximately 30 years ago as none of the present stocks exhibits characters typical of White Bliss.

Although the Green Mountain type potato has been the leading variety over the years, it is now apparent that seedling 114-3 will be a strong competitor. This new variety released in 1954 by the Experiment Station has steadily gained in acreage and is well received by the consumer. It has a tough clear skin, stores well and as a rule the flesh remains white after cooking. Scab and hollow heart can be serious in this variety in some localities. Preliminary chipping tests indicated that it was nearly as acceptable as Kennebec but neither variety has been chipped in sufficient volume to establish this point. The skin of both Green Mountain and Kennebec are very tender at harvest.

Harvesting

Potato harvesting in the Matanuska Valley begins as early as August 10th or approximately 90 days after the early plantings are made. Harvesting on a small scale proceeds until after the first week in September when the main operation begins. This leaves a maximum of 3 weeks in

which to get the tubers into storage. Both day and night temperatures are likely to remain a degree or two below freezing after October 1st, making it impossible to continue the digging operation. In the Tanana Valley, freezing weather generally sets-in at least 10 days earlier or about September 20th.

All potatoes are dug by tractor drawn, conventional chain-belt diggers, except a few that are grown in home gardens which are hand dug. Most operators depend upon hand labor for picking up the tubers immediately following the digger. This labor generally costs the grower 15 to 20 cents per bushel. Mechanical harvesters designed for bulk or bag loading are not uncommon where 10 to 40 acres of potatoes are under one management. By either method of harvesting the potatoes are bagged, transported to storage and dumped into bins. The tapered bottom truck with built-in conveyor belt for unloading may come into use for bulk handling. This system seems more practical than the pallet-box for the numerous small storages.

Storages and Facilities

Probably the weakest link in the potato industry today is the inadequacy of potato storages. There is neither sufficient space nor proper facilities in the storages to maintain storage conditions at the standards known to be desirable for preserving high quality. Storages range in types from a few well constructed concrete underground structures to rather primitive earth cellars. In numbers the underground log structures predominate because of their economy of construction. House basements that hold 10 to 40 tons are also numerous.

In general, the environment within the various types of storages is quite similar except for the house basement storage where higher temperatures prevail. The equipment to control the environment through refrigerating, heating, ventilating or circulating the air is seldom found in any one storage. Storage temperatures at completion of harvest run around 50°F and normally drop to 40°F within the first six weeks. Thereafter, in some storages the temperature may be maintained between 33 and 36°F or merely a safe margin above freezing. This is particularly true of those operators who must hold the crop for the late summer market. A few storage owners are being forced at this writing to put into operation refrigeration plants so that the crop in storage can be held for the June, July and early August market.

It is obvious that potatoes held at these low temperatures for long periods of time will be sweet when removed from storage and most likely will be sweet when they reach the consumer. Similarly, potatoes freshly dug in Alaska are noticeably sweeter to the taste than are the same varieties freshly dug in New England. This is characteristic of all vegetables in Alaska but in the potato some consider it objectionable. It is significant however, to realize that the soil temperature around the potatoes at harvest time is usually below 36°F and that the temperature of some storages into which potatoes are placed may never exceed 38°F. Consequently, new potatoes retain their sweet flavor throughout the storage period. Careful operators overcome this objectionable sweetness by exposing the tubers to a two-week warm-up period prior to shipping to the distributor.

Newer methods of handling and storing potatoes have improved the

quality of the Alaskan-grown crop. Considerable interest in developing in the use of sprout inhibitors in order to prevent losses in storage when conditions more conductive to high quality are maintained. Experimental work to date indicates that sprout inhibitors may be used in the field as a foliage cover spray or applied to the tubers after a three-month storage period. The exact time interval between field spraying and harvest has not been determined. In this environment where potato tops remain green until the tubers are harvested, it is apparent that a 10-day absorption period after spraying is sufficient to prevent sprouting of the tubers later in storage.

Markets

Markets in Alaska are for the most part determined by the buying habits of defense workers, either civil or military. These people are excellent customers and they desire a high quality product. However, their standards are based largely on the lack of sweetness and dry texture of Stateside grown potatoes. Selling to this kind of customer requires more salesmanship than is commonly practiced. The marketing problem is also magnified by the fact that these customers are on a relatively short tour of duty in Alaska and must have some real incentive to cause them to purchase a commodity slightly different from that to which they have become accustomed in the States. Experience has demonstrated that a small price differential of several cents a pound is not sufficient to modify established buying habits of persons recently arriving from the States.

Breeding and selecting potatoes in Alaska that retain the characteristics desired by these new customers is another way in which the problem can be solved. Progress has been made in this direction through the release to Alaska's certified seed growers of a new potato seedling. The new seedling has the dry texture of potatoes from the States plus the characteristic of remaining white after cooking and mashing. It has been temporarily designated as variety 43. Probably its most serious limitation is its low yielding ability under the usual method of culture. Growers are advised that seedling 43 is being released primarily for the home gardener, where quantity can be sacrificed for quality. Chipping tests have shown that good potato chips can be made from this variety.

The potato industry in Alaska has had some unfavorable seasons because of heavy frosts in mid-August. A steady market and certified seed of better adapted varieties have increased, both the demand for, and quality of, Alaska potatoes. Freedom from blight and insects distinctive to the potato may permit the potato industry of the world to look to Alaska for disease-free stocks, providing we can maintain this healthy environment.

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Marlow Pumps, Division of Bell Gossett Company takes pride in announcing a new pump model, 6YSG (TD) for flood irrigation.

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strainer, pneumatic wheel mount with 4:00 x 8 tires, and draw bar and adjustable tractor tongue hitch.

Marlow Pumps has added this new model to their present line of irrigation pumps and are now equipped to handle any type irrigation problem.

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